Title: FLOW RATES AND TEMPERATURES OF RESUSCITATION FLUIDS BY NEW INFUSION SYSTEMS

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Introduction: We compared in vitro flow rates (FR) and temperatures (T) of Ringer's lactate (RL) and packed red blood cells (PRBC) delivered through regular intravenous (iv) tubing (RIT), Medex urological tubing (UT), and the Level-1 infusion system (L-1S).

Method: RL and PRBC were left to equilibrate with room temperature for 2 hours. FR were calculated by measuring the amount of time needed to fill a 500 ml graduated cylinder. Room temperature and fluid temperature in the graduated cylinder were measured after each test to obtain the change in temperature with infusion. All fluids were infused using a pneumatic system (Alton-Dean[R]) pressurized at 300 mmHg. Cutter (Elkhart, IN) nonvented administration set with 170μ filter, reservoir chamber, and 3.5 mm internal diameter (ID) tubing was used to deliver fluids with RIT. The fluid from this system was run through a Fenwal (Deerfield, IL) warming system with 37°C plate temperature and 3.0mm tubing ID. The Medex system (Hilliard, OH) with 6mm ID tubing and 170μ filter that was used for UT was examined with no fluid warmer because the small tubing ID (3.0mm) of available warmers would reduce fluid FR. The Level-1 system (Marshfield, MA) with 170μ filter, 5mm ID tubing, countercurrent extracorporeal warming device, and air trap was used for L-1S. Tests were conducted using a 16-gauge iv catheter and an 8.5 Fr. introducer sheath at the distal end of each system. Measurements were repeated six times for each test, mean±SE of FR and T were calculated, and the data were analyzed using ANOVA. When the F values were significant, intergroup comparisons were made using the protected least significant difference method.

Results: FR with UT or L-1S were greater than that with RIT. The increase was more significant when 8.5Fr introducer was used (p<0.0005) (Tbl 1). Infusion temperatures of RL and PRBC were increased the most by L-1S, whereas fluids were infused at room temperature with UT. (Tbl 2).

Discussion: During fluid resuscitation L-1S and UT will deliver greater volumes than RIT. Improvement in FR is more pronounced with large than with small bore iv catheters. Countercurrent extracorporeal heat exchange system provides fluid temperature which is closest to the body temperature. Although FR is highest with UT, T of delivered fluid with this system is far below the body temperature because existing warming devices with small tubing ID restrict flow and thus cannot be incorporated to this system.

Table 1. Flow Rates of RL and PRBC with different infusors.

		RL (ml/min) Mean ± SE	PRBC (ml/min) Mean ± SE
RIT -	16-gauge	212 ± 17	62 ± 15
	8.5 Fr.	371 ± 58	91 ± 23
UT -	16-gauge	317 ± 8	123 ± 25
	8.5 Fr.	1560 ± 49	743 ± 121
L-1S -	16-gauge	330 ± 45	170 ± 66
	8.5 Fr.	1064 ± 145	438 ± 35

Table 2. Temperature difference (C°) between room air and infused fluid with different infusors.

		RL (mean±SE)	PRBC (mean±SE)
RIT -	16-gauge	8.22±0.41	10.27±0.98
	8.5 Fr.	7.6 ±0.62	10.8 ±0.64
UT -	16-gauge	0.02±0.04	0±0
	8.5 Fr.	0.04±0.05	0±0
L-1S -	16-gauge	13 ±0.43	11.53±1.67
	8.5 Fr.	12 ±0.61	12.55±0.84

TITLE: IMPACT OF EJECTION TIME IN SUPRASTERNAL CALIBRATION UPON ACCURACY OF TRANS-ESOPHAGEAL DOPPLER CARDIAC OUTPUT DETERMINATION

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Introduction: The suprasternal Doppler (SSD) calibration of transesophageal Doppler (TED) is critical for the agreement between thermodilution (TD) cardiac output (CO) and COTED. The correlation between COTED and COTD has recently been reported to increase, if the ejection time (ET) of SSD was within 15 % of the ETTED. [1] It was the aim of the present study to test this finding and additionally to determine, how this modification of the calibration procedure influences mean error and precision of COTED.

Methods: With informed consent and institutional approval CO was measured simultaneously by TD (9520A, Edwards) and TED (Accucom 2, Datascope) in 16 patients after aorto-coronary bypass surgery. The patients were divided retrospectively into two groups: Group 1 with ETSSD within 15 % of ETTED and group 2, where ETSSD was outside this range. The two samples of data were analyzed separately by linear regression analysis as well as by computing the bias (mean difference COTD-COTED) and the precision value (mean absolute value of bias).

Results: In 10 of 16 patients (62.5 %) the ETSSD was outside the 15 % range from the ETTED. In these patients, a correlation coefficient r=0.60, a bias of -0.90 ± 1.45 l/min and a precision value of 1.54 ± 0.73 l/min resulted (n=81). In the 6 patients with an ETSSD within 15 % of ETTED there was a similar correlation coefficient of r=0.55 (n=59) but a significantly lower bias of 0.36 ± 1.74 l/min (P<0.0001, Wilcoxon test of two samples) and a significantly improved precision value of 1.35 ± 1.15 l/min (P<0.05).

Discussion: With an ETSSD within 15 % of ETTED the mean error (bias) was considerably reduced (P < 0001) and the precision of TED significantly improved (P < 0.05). A mean precision value of 1.35 ± 1.15 l/min (range: 0.08 - 5.76 l/min) in patients with an ETSSD within 15 % of ETTED, however means, that on the average, COTED still deviated by 21 % from COTD. This huge deviation between TD and TED has to be compared with a far lower (P < 0.000001) precision value of 0.33 ± 0.32 l/min (range: 0.00 - 1.42 l/min), which has been computed for CO data of a comparison between TD and the Fick method in a similar patient population. [2] A precision value of 0.33 ± 0.32 l/min represented a mean deviation between TD and the Fick method of only 7 %.

We conclude, that despite the improved accuracy and precision of COTED values, when calibrated with an ET within 15 % of the ETTED, the Accucom 2 device is still unreliable to assess absolute CO-values.

References: [1] Anesthesiology 71:A386, 1989
[2] J Cardiothorac Anesth 4:46-59, 1990